DIVERSION EFFECTS ON FISH

APPENDIX C

CALFED ALTERNATIVE EVALUATION FOR DELTA SMELT

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CALFED ALTERNATIVE EVALUATION FOR DELTA SMELT
NARRATIVE

Draft - June 12, 1998

The delta smelt team consists of Michael Thabault, U.S. Fish and Wildlife Service, Larry Brown, U.S. Bureau of Reclamation, Dale Sweetnam, Department of Fish and Game, and Chuck Hanson, State Water Contractors. Those who participated in the creation of the first draft of the matrices include Michael Thabault, Larry Brown, and Dale Sweetnam.

The scale of each matrix box (pages C24-C29) ranges from +3 to -3 which expresses the relative impact of the effects identified that would affect delta smelt in relation to water diversions. Entries were based on a qualitative discussion of the degree to which operations or proposed operations impact the delta smelt population. The values in each box represent the combination of two estimates on the part of the Team: 1) the potential effect on the delta smelt population if exposure occurs, and 2) the probability that the population will be exposed. Therefore, caution should be used in interpretation of the matrix values. For example, exposure to toxicants includes the likelihood that fish will be exposed in addition to a judgement on the possible effects to the individuals that experience the exposure.

The delta smelt matrices were divided into "wet years" and "dry years" because distribution is strongly tied to hydrologic conditions and the effects (positive or negative) of potential actions in the delta potentially would be dampened in "wet years". The differences between the magnitude of the effects in wet and dry years is discussed in the narrative.

Definitions and Assumptions

Entrainment: Entrainment is defined as the direct effects of entrainment of delta smelt at the Cenral Valley Project and State Water Project pumping plants. Agricultural diversions are treated separately below. Consideration of other large diversions was not included in the charge to the group. Also, such consideration would require documentation and model runs for any changes in operation considered as part of CALFED or possible interactions of present operations with changes in Delta conditions that would result from the CALFED alternatives. The direct effects considered are: 1) entrainment and loss through export; 2) predation in Clifton Court Forebay and any other predation related to screens; and 3) losses due to handling of fish at fish salvage facilities. The entrainment score represents an overall effect of the three factors. The matrix includes rows for the three factors but the three rows may not necessarily add up to the total effect score assigned to entrainment. The extra scores are meant to indicate the relative importance of the various factors included in entrainment.

Hydrodynamics: Hydrodynamics is defined to include the indirect effects of holding delta smelt in the interior Delta longer than would occur under more natural flow conditions. We assumed that the mortality rate in the interior Delta is higher than that in Suisun Bay, where most juvenile rearing occurs. Thus, the effect does not imply changes in mortality rates but differing durations of exposure to different mortality rates. The higher mortality rate was presumed to occur through longer exposure of delta smelt to undefined mortalities that occur in the central Delta. These sources of mortality could include predation by species common in the Delta such as largemouth bass and silversides, differences in water quality, or differences in food production and availability in different areas. The Team recognizes that this assumption is based on sparse data but the view is consistent with the existing view of delta smelt ecology (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b). The environmental cues delta smelt use to migrate to Suisun Bay (assuming active rather than passive transport) are unknown but the simplest assumption is that they can detect or use the net direction of water movement in combination with tidal flux to choose a migration path. If this process is correct, delta smelt could be transported, either actively or passively, in the direction of the net flows described in the modeling runs that form the basis of the assessment. The effects of hydrodynamics were assessed by explicitly considering the following geographic locations identified in modeling runs: 1) cross Delta flow; 2) Qwest; 3) Old River @ Bacon Island; 4) Sacramento River at Rio Vista; 5) San Joaquin River at Antioch.

Predation: Predation includes all predation other than that occuring in Clifton Court Forebay and in front of screens.

Handling: Handling losses are included in entrainment. Handling is associated with a very high level of mortality given the delicate nature of delta smelt.

Food supply: Recent studies of delta smelt feeding indicate that the availability of appropriate food types may be very important at certain points in the delta smelt life cycle and for overall survival (Nobriga 1998, Lott and Nobriga, in prep.). Food supply summarizes the best guess of the team as to the effects certain actions will have on availability of food to the population.

Shallow-water habitat: Assessments of shallow-water habitat are based on possible effects on spawning habitat and food supply. The Team assumes that the majority of shallow-water habitat rehabilitation will involve perennial tidal marsh located in the interior Delta. Nothing definitive is known about the need of delta smelt for perennial tidal marsh habitat. This type of habitat is known to be used for spawning but it is unclear if spawning habitat is limited under present conditions. There is no compelling evidence that this habitat is used as rearing habitat. Past assessments of delta smelt ecology suggest that shoal habitat is important in Suisun Bay (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b) indicating that rehabilitation of shoal habitat in the western Delta might provide some benefit. However, ongoing studies of delta smelt habitat use suggest that larval and juvenile delta smelt are not selecting the shallow (<3m) edges of the channels compared to the deeper mid-channel areas (Sweetnam, unpublished data). Given the uncertainty in location and types of habitats to be rehabilitated and the benefit of shallow-water habitat as rearing habitat, shallow-water rearing habitat was not considered in the assessment.

Water quality (temperature): The Team believed that none of the alternatives would have a major effect on in-Delta water temperatures. This row was scored 0 through all matrices; therefore it was omitted from the matrices.

Salinity/X2 (originally called Water quality (salinity)): For delta smelt, the original "Water quality (salinity)" row was changed to Salinity/X2. We believe this better defines the variable of interest for delta smelt.

Agricultural diversions: The Team assumed an aggressive program of screening and consolidation of in-Delta agricultural diversions. Screen design was assumed to have some benefit for various life stages of delta smelt

Sources of uncertainty

The Team identified many sources of uncertainty. New data addressing. The major areas are identified below. Additional text is provided in the narrative for each of the alternatives.

We do not know the absolute size of the delta smelt population. All effects are based on sampling data from the various existing monitoring programs, including: 1) mid-channel vs. shallows larval sampling; 2) the 20-mm estuary-wide juvenile survey (includes flooded tracts); 3) Real-time Monitoring Program; 4) midwater trawling; 5) kodiak trawling; and 6) fish salvage at the state and federal pumping plants. The Team considered all of these relevant programs to minimize any bias that might result from considering data from any single sampling method or sampling design.

Screening criteria for both large project screens and smaller agricultural screens are unknown. Benefits for delta smelt are assumed; however, recent behavioral studies suggest that it may be very difficult to design screens that actually benefit delta smelt to a significant degree (Swanson et al 1998). It was also assumed there was some benefit to all life stages, which may not be the case depending on final screen design.

The benefits of shallow-water habitat rehabilitation to delta smelt are unknown. Such habitat is used for spawning and may contribute to overall productivity of the system. It is not known if spawning habitat is a limiting factor for the population. Shallow-water habitat is not believed to be an important rearing habitat for delta smelt. The Team assumes that the majority of shallow-water habitat rehabilitation will involve perennial tidal marsh located in the interior Delta. Nothing definitive is known about the need of delta smelt for perennial tidal marsh habitat. There is no compelling evidence that this habitat is used as rearing habitat. Past assessments of delta smelt ecology suggest that shoal habitat is important in Suisun Bay (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b) indicating that rehabilitation of shoal habitat in the western Delta might provide some benefit. However, ongoing studies of delta smelt habitat use suggest that larval and juvenile delta smelt are not selecting the shallow (<3m) edges of the channels compared to the deeper mid-channel areas (Sweetnam, unpublished data). Given the uncertainty in location and types of habitats to be rehabilitated and the benefit of shallow-water habitat as rearing habitat, shallow-water rearing habitat was not considered in the assessment.

We have little understanding of in-Delta predation dynamics on delta smelt.

As indicated at several points above, we have relatively little understanding of limiting factors for the delta smelt population. Recent studies suggest that availability of specific food types at specific times may be very important (Nobriga 1998, Lott and Nobriga, in prep.).

Existing Conditions

Entrainment: Entrainment values are based on historical salvage of delta smelt at the water project diversions in the South Delta. The strongest negative effects occur in the late spring/early summer when young-of-the-year delta smelt become large enough to be counted as salvage at the facilites in May, June and July. Entrainment of larval and early juvenile delta smelt < 21 mm are not counted as take at these facilities, therefore salvage data does not represent larval losses to entrainment and the peak effect might be prior to the salvage peaks observed in May or June. Screening efficiencies and pre-screening losses (e.g., predation) for delta smelt are not known so actual losses of delta smelt cannot be calculated. We assume that significant predation occurs on delta smelt entrained into Clifton Court Forebay, however it may be comparable to other species of the same size and shape (and swimming ability). The Team acknowledges that there are differences among life stages in the probability of survival to reproduction, with earlier life stages having lower probabilities but without carefully designed and implemented studies of life-stage specific mortality rates, the magnitude and importance of the differences is uncertain. The Team did qualitatively consider the relative importance of larval, juvenile, and adult effects.

Delta smelt usually do not survive the handling process, therefore the larger the potential for handling smelt, the larger the potential negative effect. Handling of delta smelt was also assumed to be proportional to entrainment effects. More delta smelt are entrained in dry years therefore the potential for handling mortality increases. Survival may also be influenced by water temperature, which would be higher in dry years.

Secondary effects of moving delta smelt out of optimal delta smelt rearing areas is covered under hydrodynamics.

The negative effects of entrainment are strongest in dry years when a larger proportion of the population is located in the delta for a longer period of time. In wet years, the population is more widely dispersed and distributed from the Delta to Suisun Bay. A second period of entrainment occurs in the late winter and early spring when pre-spawning adults move to freshwater to spawn.

Hydrodynamics: The effects of project related hydrodynamics on delta smelt occur mainly in the spring and summer months when pre-spawning adults move upstream to spawn and young-of-the-year delta smelt are present in freshwater before migrating to brackish water in the summer. The rest of the year, delta smelt are usually associated with the low salinity areas of the estuary west of the Delta, primarily Suisun and Grizzly bays. The negative effects of hydrodynamics in dry years are stronger and longer in duration than in wet years (DWR 1994, Biological assessment of ...).

Cross-Delta Flow: There may actually be some Cross-Delta flow in wet years but little effect is expected because of general high outflow conditions in wet years. In dry years, Cross-Delta flow will be [positive] larger and tend to move delta smelt spawned above the Delta Cross-Channel toward the central and southern Delta channels. The modeling studies used in this assessment use the variable Cross Delta Flow which combines flows in Georgiana Slough, the Delta Cross

Channel, and Snodgrass Slough/Alternative 2 discharge. The modeling runs provided assume that the Delta Cross Channel Gates are open from 1 July to 1 November. Particle tracking results verify that Cross-Delta flow occurs through Georgiana Slough when the Cross Channel Gates are closed.

Qwest: Qwest is generally positive over the period of record so it was assumed that Qwest would be positive in wet years and there would be little effect on delta smelt. In dry years, Qwest is negative in most months and only slightly positive in the remaining months. As described earlier, the retention of delta smelt in the Delta was felt to be a significant negative effect on the population, particularly for larvae and juveniles in the spring months.

Old River @ Bacon Island: Based on the 1975-1991 period of record analyzed, flow in Old River was negative during all months. Spawning in wet years is diffuse and significant spawning can occur in the central and southern Delta. A slight negative effect was assigned in the winter because adults could be induced to spawn farther south than they would otherwise and larvae and juveniles spawned in the area would be held in the area of the pumps longer. During dry years negative flow in the area is assumed to be high. This negative flow is assumed to retain larvae and juveniles in the southern Delta and this is presumed to have a negative impact on survival. Particle-tracking model results indicate that 62% of the particles injected into Old River are exported from the pumping facilities within 20 days. This suggests that weakly swimming larvae are likely moved toward the pumps for some period of time, even if they are not directly entrained.

Sac River @ Rio Vista: Sacramento River flow is strongly positive during wet years with no effect expected on delta smelt. Sacramento River flow will be lower in dry years but this is not felt to be a major effect on the delta smelt population. Most of the negative effects are already implicitly included in the Qwest effect indicated above. In dry years, delta smelt accumulate in the Sacramento River and will be subject to the Qwest effect. The delta smelt remaining in the more upstream portion of the Sacramento River were also felt to be negatively affected, but not to the degree of the rest of the population. Current regulatory requirements in the 1995 Water Quality Control Plan limits the movement of X2 into the Sacramento River channel. The Team believed a relatively small proportion of the population used the portion of the Sacramento River above Hood for spawning in dry years.

San Joaquin River @ Antioch: San Joaquin River flows likely stay positive during all months during wet years with little effect expected on delta smelt. In dry years, flow in the San Joaquin River is dramatically reduced. Significant reverse flows occur in some months. Moyle et al. (1992) hypothesized that this is a negative effect on the delta smelt population. The negative values for this parameter indicate longer residence time in an area where survival was believed to be relatively poor. Fish in this area might also be vulnerable to moving into areas subject to the other effects described above (e.g. Old River flows).

Predation: There were two main types of predation that were considered for delta smelt: larval predation by inland silversides, and predation at structures other than screens by striped bass, largemouth bass, etc. Predation effects are diminished in wet years when the smelt population was widespread with a larger proportion out of the Delta. The potential for inland silverside predation appears to be greatest in drier years when the majority of the population spawns above the Confluence. Predation on adults was considered to be relatively low with the effect increasing in months when larvae and juveniles are present.

Food Supply: Recent studies suggest that *Eurytemora affinis* is a preferred food item of delta smelt Nobriga 1998, Lott and Nobriga in prep.). Redutions in *Eurytemora* abundance through the introduction of exotic species such as clams (*Potamocorbula*) and copepods (*Psuedodiaptomus, Sinocalanus*, etc.) has led to the potential for food limitation for delta smelt. Wet years provide higher levels of food production in the estuary and decrease the effects of the clam on the ecosystem.

The negative effect of exporting a proportion of the food production with withdrawal of water from the estuary was also considered. This effect was not considered important in wet years. In dry years a negative effect was assigned. The negative effect appears earlier than direct effects of entrainment because the Team felt that earlier export of primary production, nutrients, and zooplankton might have some effect on productivity later in the season, even though fish were not present.

Shallow/Nearshore Habitat: Shallow or nearshore habitat is important to delta smelt as spawning habitat. It is not believed to be as important to delta smelt as rearing habitat. It was difficult to assign a value to this for two reasons. First, while it is clear that such habitat has declined it is unkown whether spawning habitat is a limiting factor on the population. Effects were assigned during the spawning season from December through May; however, uncertainty with the existence and magnitude of any effect is very high. Even thought the location and amount of available spawning habitat varies between wet and dry years the team did not feel that the magnitude of the effect varied enough to warrant a change in effect especially given the level of uncertainty involved. Second, the Team also believes that shallow-water habitat may have some value as a source of nutrients and production to the channels.

Water Quality (Temperature): Delta water temperatures are not controlled by water project operations. As water temperatures increase in the delta, delta smelt are thought to move to cooler portions of the estuary, therefore the delta smelt team decided that there was "no effect" of temperature on delta smelt for either water year type.

Water Quality (Salinity/ X2 Position): The delta smelt team decided that the effects of salinity on delta smelt are best described by the relationship between delta smelt abundance and X2 position. Delta smelt are most abundant when X2 is located in Suisun Bay in the spring. Although the relationship is somewhat weak, it does explain a statistically significant proportion of the variance (about 20%). However, much of the variability in the delta smelt population is unaccounted for by X2 alone. Maintenance of X2 position is mainly dependent on freshwater inflow to the estuary. In wet years, the salinity gradient has little effect on delta smelt except in the summer months when outflow declines and the gradient moves upstream into the Delta. In dry years, the effects of salinity may be much longer and last from February through November. The months of February through April were given positive effects in order to reflect export limitations and X2 flow requirements under the 1995 Water Quality Control Plan.

Agricultural Diversions: There are over 1800 agricultural diversions in the delta, which at times in the summer may export a similar magnitude of water as the export facilities in the south delta. Additional agricultural diversions in Suisun Marsh have the ability to entrain delta smelt when the population is located farther downstream in Suisun Bay. Not only do these exports have the potential to entrain larval and juvenile fishes, plankton and nutrients are also diverted. There may be agricultural diversion effects on delta smelt year round in different areas of the estuary, however the majority of impact would be at high levels of diversion in the spring and summer.

No Action Conditions

Entrainment: Based on modeling runs the majority of the increased diversions resulting from the 2020 level of demand would occur in December-March and July-August. The largest increases in exports (resulting in higher levels of entrainment) occur in February and March in wet years, and December-March in dry years. During this period, pre-spawning adults might be entrained at higher rates. The July increase in wet years was given a greater effect because young-of-year delta smelt are more likely to be in the area at that time compared to August.

Hydrodynamics: Changes in hydrology based on the increased level of demand are similar to existing conditions with increases in negative effects observed throughout the winter and spring. The magnitude of the effect might be greater in wet years since additional water would be available to be exported in the spring. Negative effects were lessened in April of both year types for export constraints already in place. The reduction did not carry through May because protections are curtailed while large numbers of young smelt are still present. San Joaquin River at Antioch appeared slightly worse in December and January, which may have an effect on adult delta smelt staging to move into the Delta.

Predation: No change from existing conditions for wet years with no additional effect. In dry years there is the potential for increased effects in the winter when additional water is exported; however, no changes in scores were made.

Handling: No change from existing conditions for wet years with no additional effect. In dry years there is the potential for increased effects in the winter when additional water is exported; however, no changes in scores were made.

Food Supply: With increased exports in the winter, higher levels of primary production and zooplankton are also exported. The team decided that this additional effect would be observed in December and January.

Shallow/Nearshore Habitat: The increased level of demand in the No Action Alternative would not change the amount or effect of shallow/nearshore habitat.

Water Quality (Temperature): No change from existing conditions.

Salinity/ X2 Position: According to the modeling runs available, there is little discernible difference in X2 position between the existing and no action conditions. The numbers in the matrix reflect these numbers. (For the consideration of the group our original comments were: With increased exports in the winter and early spring, there might be additional effects on habitat conditions in the spring. In wet years, these effects may be observed in January and February if rainfall occurs later in the spring. In dry years the effect may be observed from December through March. Our original comments were based on extrapolations from total Delta outflow.)

Agricultural Diversions: Unless there is same change in demand, no change in existing conditions is anticipated.

Common Programs

Entrainment: The Common programs do not address this issue.

Hydrodynamics: The Common programs do not address this issue.

Predation: The Common programs do not address this issue.

Handling: The Common programs do not address this issue.

Food Supply: Restoration programs and increases in Shallow/nearshore habitat may lead to increases in primary production, which may be a benefit year round.

Shallow/Nearshore Habitat: Additional shallow/nearshore habitat may benefit delta smelt in terms of spawning habitat. Shallow water areas as nursery habitat do not appear to be that important to delta smelt. This benefit is uncertain because there is no evidence that shallow/nearshore habitat is a limiting factor on the population.

Water Quality (Temperature): Common programs may affect the temperature of water coming into the Delta but no in-Delta change is anticipated.

Salinity/ X2 Position: The Common programs do not address this issue.

Agricultural Diversions: There is a net benefit of screening for delta smelt, which may be observed throughout the entire year. The largest magnitude of a positive benefit of screening would be observed in months when delta smelt are in close proximity to agricultural diversions and demand is high. This assumes that screening criteria and diversion consolidation can be designed to minimize effects on all life stages of delta smelt. Benefits will have to be adjusted if only certain life stages are benefited. This benefit includes screening and consolidation in Suisun Marsh.

Alternative 1

Alternative 1 was assumed to be the result of the benefits of the common programs above the existing conditions added to the No Action Alternative (expressed as Alt 1 = (Common Programs - Existing Conditions) + NA). See the text for the No Action alternative for explanations of factors.

Entrainment:

Hydrodynamics:

Predation:

Handling:

Food Supply:

Shallow/Nearshore Habitat:

Water Quality (Temperature):

Water Quality (Salinity/ X2 Position):

Agricultural Diversions:

Alternative 2

Entrainment: Increased exports from the southern Delta in December through March in all years were assigned a large negative effect because of the size of the increase (about 3,000 cfs). A similar large increase occurred in July and August.

Less effect was assigned to direct entrainment at the times of the year when delta smelt would be large enough for effective screening, if screens with the correct criteria can be designed. Additional negative effects were assigned to handling because screened fish will have to pass through a bypass system. Clifton Court Forebay predation effects are now defined as taking place in front of the screens rather than in the Forebay proper. The greater effect in dry years results from a larger proportion of the population experiencing the effects.

Hydrodynamics: In wet years, modeling results indicate improvements in Qwest; however, Cross-Delta flows and Flows at Old River @ Bacon Island get worse. These negative effects outweigh the improvement in Qwest. In dry years, the negative effects are magnified, especially for Cross-Delta flow and Old River at Bacon Island. Reductions in flow of the Sacramento River were also assigned a negative value. Qwest remained favorable, except for June, July and August, when slight negative effects were assigned. Conditions in the San Joaquin River at Antioch remained favorable all year. The large negative effect of Alternative 2 is linked not only to hydrodynamic changes but to interactions with the physical changes as well. The Team believes that with this alternative any net production of delta smelt to the east of the "new" canal would be completely lost. It also seemed possible that young-of-year produced to the west of the new canal could be at risk if tidal action periodically moves young-of year in and out of the areas influenced by the new canal. It seems likely that hydrodynamic effects of east-west (more or less) tides on the water moving north-south (more or less) in the canal will be complex and difficult or impossible to model with existing tools.

Predation: No change from Alternative 1.

Food Supply: No change from Alternative 1.

Shallow/Nearshore Habitat: The possible benefits of shallow/nearshore habitat were reduced because strong Cross-Delta flows would reduce the value of such habitat within the influence of the diverted water.

Salinity/X2 Position: No change from Alternative 1.

Agricultural Diversions: No change from Alternative 1.

Alternative 3

Entrainment: The isolated facility reduces entrainment effects substantially and a large positive benefit (compared to existing conditions) is assigned. Reduction in predation is assigned a similar benefit. There is still some pumping from the South Delta and some negative effect is still assigned to the fish that would go through the bypass facility.

Hydrodynamics: Alternative three improves Cross-Delta and Old River flows substantially resulting in substantial improvement for delta smelt. Positive benefits are assigned to increased San Joaquin River flows in this alternative because there is no longer any complicating interactions with Cross-Delta and Old River flows, which stay positive in all months.

In dry years positive benefit was assigned to Old River at Bacon Island because negative flows were reduced and in February-June were near zero.

Predation: Predation in the Delta declines because hydrodynamics are now favorable and fish are no longer held in the Delta for an extended period of time.

Food Supply: No major change from Alternative 1.

Shallow/Nearshore Habitat: No change from Alternative 1.

Salinity/ X2 Position:

Modeling results indicate a decrease in X2 position of roughly 2 kilometers in July and 6 kilometers in August (also 4 kilometers in September). This was given a positive benefit though it seems inconceivable to the Team that this is not a mistake. Why would Alternative 3 be operated in this way?

Agricultural Diversions: No change from Alternative 1.

Primary Issues

1. **Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?**

No Action: Larvae and young juveniles are the most sensitive life stages. These life stages are present in the spring and early summer. The major effects occur in the central and south Delta where altered hydrodynamics and entrainment are important. As delta smelt become adults, they migrate downstream to brackish water areas in the fall and winter and are considered less vulnerable to diversion effects. Pre-spawning adults migrating back into freshwater to spawn in the late winter and early spring become vulnerable to entrainment effects once again.

Alternative 1: The same as No Action.

Alternative 2: Larvae and young juveniles are still the most sensitive stages and are still vulnerable at the same times. The major changes in hydrodynamics anticipated with Alternative 2 are believed to be a negative factor for all life stages of delta smelt, but especially these sensitive stages. These negative effects are expected to be most severe in the eastern Delta.

Alternative 3: Alternative 3 was given high benefit because of its positive effects on returning Delta hydrodynamics to a more "natural" condition, meaning the rivers and most channels maintain positive outflows at most times and places. Positive benefits for delta smelt may be high compared to other species because it is the only species to complete its entire life cycle in the estuary.

2. **Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?**

No, common program actions have very uncertain effects for delta smelt but it seems unlikely that the positive benefits will outweigh the entrainment and hydrodynamic effects.

3. **To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?**

Alternative 1: Little effect.

Alternative 2: Makes things much worse.

Alternative 3: Makes things better.

4. **To what extent can diversion effects be offset by modifications to the alternatives or by operational changes?**

(Not to be answered yet)

5. **What is the risk and chances of success of species recovery for each alternative?**

For the delta smelt team recovery is defined in "The Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes" (Attachment 1). Alternative 1 is not a major change and probably has little influence on probability of recovery. Alternative 2 seems likely to negatively affect probability of recovery. Alternative 3 seems likely to improve the probability of recovery. All of these assessments are subject to the uncertainties already identified above.

6. **What increment of protection or improvement for delta smelt will be provided by other programs such as the CVPIA, biological opinions?**

The protections set forth for delta smelt under the Biological Opinion (USFWS 1995a) on the operation of the State and Federal water project diversions are similar to conditions set forth in the 1994 Water Accord and therefore are considered part of the baseline conditions known as "existing conditions" in the model runs provided.

7. **What degree of benefit and impact will the common programs provide?**

We estimated that improvement would occur with the common programs. Much of the benefit predicted is due to the creation of additional shallow water habitat of several different types. The effect on delta smelt is uncertain. Much of this uncertainty stems from the scarcity of evidence of the effects of increasing such habitat. Delta smelt use such habitat for spawning but it seems to be of no special importance as rearing habitat. There is no evidence that spawning habitat is a limiting factor for the delta smelt population. While the habitat will also be favorable for predators, the increased spawning habitat and possible increases in Delta primary productivity and food supply were believed to be possible benefits and were assigned benefits even though this is an area of high uncertainty. Screening Delta diversions and improved Delta water quality are also expected to be beneficial.

8. What are the direct and indirect effects on delta smelt populations resulting from each Alternative and what is the expected response of the populations to these effects?

The improvement in conditions for Alternatives 1 and 2 are purely a result of the benefits assigned to the common programs. Neither of these alternatives improves in-Delta hydrodynamics to a significant degree, and the team believes that Alternative 2 will result in hydrodynamic conditions that are significantly worse than any other alternative. Alternative 3 performs best for delta smelt because the hydrodynamic changes associated with this alternative appear likely to have positive effects on the delta smelt population in addition to the positive effects of the common programs.

A summary of our assessments suggest that Alternatives 1 and 2 will aid the delta smelt population somewhat, through improvements related to the common programs, and that Alternative 3 represents a significant improvement. However, it is unclear if the population will actually benefit to the degree anticipated in this document. Recent studies suggest that the success of the delta smelt population might be linked to timing and abundance of particular food organisms. Further, the ecology of these food organisms may be linked more to the effects of introduced predators and competitors than to the issues addressed in the alternatives. If this is actually the case, then the anticipated beneficial effects of the alternatives for delta smelt might not actually be achieved.

9. **What Sacramento River flow is required below a Hood diversion to protect delta smelt?**

10. **What survival rate can be expected for delta smelt passing through Sacramento River screen and pumps in Alternative 2?**

11. **Should there be a screen on the Sacramento River intake of Alternative 2?**

    Yes.

12. **What are the logical stages for a preferred alternative?**

13. **What is the range of biological criteria that should be considered in the operations of the three alternatives?**

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References

(including Attachment 1)

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society.121:67-77.

Swanson, C. P.S. Young and J.J. Cech. 1998. Swimming performance of delta smelt: maximum performance, and behavioral and kinematic limitations on swimming at submaximal velocities. Journal of Experimental Biology: 201, 333-345.

Sweetnam, D.S. and D.E. Stevens. 1993. Report to the Fish and Game Commission: a status review of the delta smelt, (*Hypomesus transpacificus*) in California. California Department of Fish and Game. Candidate Status Report 93-DS.

U.S. Fish and Wildlife Service. 1995a. Formal consultation and conference on effects of long-term operation of the Central Valley Project and the State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail, March 6, 1995. U.S. Fish and Wildlife Service, Portland Oregon. 52pp.

U.S. Fish and Wildlife Service. 1995b. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife service, Portland, Oregon. 195pp.

Attachment 1

The following is the Recovery section of the Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes for delta smelt (USFWS 1995b), pages 29-34 and 37-38:

RECOVERY

Recovery Objective

The objective of this part of the Delta Native Fishes Recovery Plan is to remove delta smelt from the Federal list of threatened species through restoration of its abundance and distribution. Recovery of delta smelt should not be at the expense of other native fishes. The basic strategy for recovery is to manage the estuary in such a way that it is a better habitat for native fish in general and delta smelt in particular. Improved habitat will allow delta smelt to be widely distributed throughout the Delta and Suisun Bay, recognizing that areas of abundance change with season. Recovery of delta smelt will consist of two phases, restoration and delisting. Separate restoration and delisting periods were identified because it is possible that restoration criteria can be met fairly quickly in the absence of consecutive extreme outflow years (I. e., extremely wet or dry years). However, without the population being tested by extreme outflows there is no assurance of long-term survival for the species. Thus, restoration is defined as a return of the population to pre-decline levels, but delisting is not recommended until the population has been tested by extreme outflows. Delta smelt will be considered restored when its population dynamics and distribution pattern within the estuary are similar to those that existed in the 1967-1981 period. This period was chosen because it includes the earliest continuous data on delta smelt abundances and was a period in which populations stayed reasonably high in most years (see below for a more detailed justification). The species will be considered recovered and qualify for delisting when it goes through a five-year period that includes two sequential years of extreme outflows, one of which must be dry or critically dry. Delta smelt will be considered for delisting when the species meets recovery criteria under stressor conditions comparable to those that led to listing and mechanisms are in place that insure the species' continued existence.

Recovery Criteria

Restoration of delta smelt should be assessed when the species satisfies distributional and abundance criteria. Distributional criteria include: (1) catches of delta smelt in all zones 2 of 5 consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in at least one zone for the remaining 2 years. Abundance criteria are: delta smelt numbers or total catch must equal or exceed 239 for 2 out of 5 years and not fall below 84 for more than two years in a row. Distributional and abundance criteria can be met in different years. If abundance and distributional criteria are met for a five-year period the species will be considered restored. Delta smelt will meet the remaining recovery criteria and be considered for delisting when abundance and distributional criteria are met for a five-year period that includes two successive extreme outflow years, with one year dry or critical. Delisting is contingent on the placement of legal mechanisms and interagency agreements to manage the CVP, SWP, and other water users to meet these criteria. Both criteria depend on data collected by DFG during the FMWT, during September and October.

Justification for using FMWT numbers: The FMWT covers the entire range of delta smelt distribution and provides one of the two best measures of delta smelt abundance (Sweetnam and Stevens 1993). The summer tow-net survey samples juveniles of this annual species and provides another good measure of abundance. The FMWT provides a better measure of abundance because it samples pre-spawning adult delta smelt. An index based on pre-spawning adults, rather than on juveniles, which are vulnerable to high mortality, provides a better estimate of delta smelt stock and recruitment. The FMWT may not be as efficient at sampling delta smelt compared with the Kodiak trawl, which is pulled by two boats and tends to sample the upper water column, but it has been continuously done for almost 30 years (since 1967) and so has a solid base of historical data with known sampling error.

September and October numbers of adults were chosen, because these are the months that were sampled most consistently in all years. In addition, when delta smelt begin moving upstream to spawn in November and December, they occur less frequently in the FMWT. Weather conditions are also more stable in September and October. The more frequent storms of November and December produce conditions that result in more variability in fish-capture numbers. There is a high correlation between September and October numbers and total numbers ($r= 0.93$).

Number of delta smelt rather than abundance index was used for recovery criteria. The abundance index was initially developed for striped bass. Numbers were chosen because delta smelt occupy the upper water column. Multiplying delta smelt captured by volume of water in the portion of the estuary sampled probably doesn't give a good representation of the number of fish present. Using numbers for delta smelt simplifies the assumptions of the criteria and there is a close correspondence between numbers and the abundance index for delta smelt ($r=0.89$).

Justification for using 1967-1981 for the standard: Graphs from different surveys were used to establish pre-decline and post-decline periods for delta smelt (Moyle *et al.* 1992). The surveys included were: (1) FMWT, (2) summer tow-net, (3) Suisun Marsh fish survey, and, (4) the bay survey (Appendix A). Each of the surveys showed slightly different patterns of decline. The most noticeable trend is that delta smelt decline began earlier in the south and east Delta than in the rest of the estuary (Sweetnam and Stevens 1993). The pre-decline period identified by Moyle *et al.* (1992) is 1967 through and including 1981; the post-decline period is 1982-92. Using 1982 as the beginning of the decline period is justified because 1982 and 1983 were very wet years and declines in delta smelt abundance correspond to extremes in outflow: very wet and very dry years result in low numbers (Moyle *et al.* 1992). The mechanisms for this are that delta smelt larvae are washed downstream of favorable nursery grounds in wet years; dry years decrease spawning habitat and move adults and juveniles upstream into less productive deep river channels where they are more at risk to entrainment in water projects.

Other alternatives were proposed for the decline period. One possibility was to use 1981 as the beginning of the decline period because it was a dry year followed by the wet year 1982. The occurrence of a dry year followed by a wet year produces a double stress on delta smelt and this may have been the true beginning of the decline. An argument can also be made for using 1983 as the beginning of the decline: this is the year that delta smelt declined in the FMWT and so is consistent with other recovery criteria (which is based on the FMWT). There is a noticeable change in geographic distribution of delta smelt in 1982 and 1983, which corresponds to the periods used in the Biological Opinion and the decline in FMWT numbers, respectively. The decline in delta smelt numbers actually occurred over a multi-year period from 1981-1983; the midpoint of this period, 1982, was used as the beginning of the decline.

Justification for including distributional recovery criteria: Geographical distribution and numbers of fish were used to measure recovery because recovery of delta smelt should include a restoration of the species to portions of their former range. Before 1982, delta smelt were captured at an average of 19 FMWT stations; after 1981 they were captured at an average of 10 stations. From 1986-1992, the delta smelt population was concentrated in the lower Sacramento River between Collinsville and Rio Vista (Sweetnam and Stevens 1993). Historically, when delta smelt were more abundant, the population was spread from Suisun Bay and Montezuma Slough through the Delta. The shallow, productive waters of Suisun Bay and Suisun Marsh are important habitat for delta smelt. Large percentages of delta smelt catches are in Suisun Bay when outflows are sufficient to maintain the mixing zone and salinities of 2-3 parts per thousand in that area. When concentrated in deep river channels due to intrusion of high salinities in Suisun Bay, delta smelt are more vulnerable to entrainment in water project facilities, predation and other risks.

FMWT stations chosen to measure recovery: Stations chosen for recovery criteria were sampled in every year (that the FMWT was conducted) and had a record of delta smelt catches. Occasionally, this was modified to include stations sampled in all years but one (stations 509, 511, 602). The total number of stations is 35 and there is a strong correlation between delta smelt at **these stations and** total numbers of delta smelt (r = 0.94).

Zone A (North Central Delta).
11 stations
802 804 806 808 810 812 814 903 904 906 908

Zone B1 (Sacramento River)
5 stations
701 703 705 707 709

Zone B2 (Montezuma Slough)
4 stations
602 604 606 608

Zone C (Suisun Bay)
15 stations
410 412 414 416 418 501 503 505 507 509 511 513 515 517 519

Distributional criteria: Distributional criteria were developed on the basis of number of stations in each zone where delta smelt were captured during the predecline period (Tables 2.2, 2.3, Figures 2.7 and 2.8). Each zone has the following criteria: (1) in Zone A, delta smelt must be captured in 2 of 11 sites; (2) in Zone B (includes B1 and B2), delta smelt must be captured in 5 of 9 sites; and (3) in Zone C, delta smelt must be captured in 6 of 15 sites. Criteria for all zones need to be met in all years. Criteria for recovery are as follows: (1) site criteria must be met in all zones 2 of 5 consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in

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at least one zone for the remaining 2 years. A failure in all zones in any year will result in the start of a new 5-year evaluation period for the distributional criteria. Failure to meet these criteria in consecutive years should be avoided because such conditions will place the species in danger of extinction. These distributional criteria will be met in concert with the abundance criteria.

Abundance criteria: Abundance of delta smelt constituting recovery is based on pre-decline delta smelt numbers from the FMWT (Table 2.3). Two numbers were identified that had to be met during the five-year recovery period: (1) a low number below which abundance can not fall for more than two years in a row and, (2) a high number to be reached or exceeded in two out of five years. A low number was chosen to protect delta smelt from the risk of extinction during prolonged droughts or extremes of outflow. The lowest two-year running average of abundance in the pre-decline years was used for the low number. A running average was used because of the great degree of variability in delta smelt abundance. The high number is the median of delta smelt abundance in pre-decline years, in other words, abundance of delta smelt half of the time in the pre-decline period. To meet recovery criteria, delta smelt abundance must meet or exceed 239 in two out of five years and the two-year running average must never fall below 84. If any of these conditions are not met, the five-year recovery period will start again.

Length of restoration and recovery period: Delta smelt generation time and frequency of occurrence of very dry and very wet years were used to determine appropriate length of the restoration period. Because delta smelt live only a year, a five-year recovery period would include five generations of delta smelt; five generations is comparable to the period used in recovery plans for other fishes. A five-year restoration period has a reasonable probability of including years with extreme outflow. The 40:30:30 (Footnote: Year-type categories adopted by the SWRCB in the 1991 Salinity Control Plan.) Sacramento River Indices (SRI) from 1906-1992 was used for this analysis. The goal was to identify a period that had a high probability of including two extreme outflow years, preferably back-to-back. This method was chosen because when two extreme years occur together, delta smelt are at risk of extinction. Because extremes in outflow led to the listing of the delta smelt, the period identified for recovery differs from restoration and includes a stressor period. Delta smelt will be considered for delisting when abundance and distributional criteria have been met over a five-year period that includes two sequential years of extreme outflows. However, delisting may not take place until there is reasonable assurance that long term solutions to delta problems are in place. One of the extreme years must be dry or critically dry (SRI $\leq$6.0); the other can be wet SRI $\geq$11.2). Other indices can be used to identify dry, critically dry, and wet years, if appropriate. Dry conditions are included because delta smelt losses increase in dry and critical years due to high proportions of outflow diverted, which results in habitat loss and increased entrainment in water projects. Analysis of the historical hydrograph indicated that there is about a 24 percent chance that two extreme years (one being dry or critical) will occur in a five-year period. There is a 48 percent chance (based on the historical hydrograph) that the period of time required to delist delta smelt could be 10 years. According to existing records, the longest amount of time required to delist delta smelt is 38 years.

Table 2.2 Number of sites with delta smelt from FMWT September and October numbers for 35 stations. Numbers in brackets refer to station numbers. The FMWT did not sample in 1974 and 1979. See Figure 2.8 for how minimum number of sites was determined.

Sites

Year	Zone C Suisun Bay (410-519)	Zone B Montezuma Slough Sacramento River (602-709)	Zone A North Central Delta (802-908)
		Pre-decline	
1967	6	8	2
1968	9	6	8
1969	11	7	0
1970	12	8	7
1971	13	8	8
1972	12	8	9
1973	9	9	4
1975	12	5	5
1976	1	5	2
1977	0	5	5
1978	11	6	0
1980	10	8	3
1981	8	6	0
Minimum number of sites	6 of 15	5 of 9	2 of 11
Number of years minimum number of sites occurred	11 out of 13	13 of 13	10 of 13
		Post-decline	
1982	6	6	1
1983	5	4	0
1984	9	3	0
1985	2	3	0
1986	10	5	1
1987	2	4	1
1988	3	3	0
1989	6	5	3
1990	4	6	0
1991	4	6	3
1992	0	5	1
1993	12	6	4
1994*	1	5	1
1995*	14	7	1
1996*	8	4	2
1997*	3	4	1
Number of years minimum number of sites occurred	7 out of 16	9 of 16	4 of 16

Table 2.3 Numbers used for delta smelt abundance criteria. Numbers are from the September and October FMWT for 35 stations. The FMWT did not sample 1974 and 1979.

Year	Number	Two-year running average
	Pre-decline	
1967	139	
1968	251	195
1969	128	190
1970	589	359
1971	352	471
1972	551	452
1973	305	428
1975	239	272
1976	22	131
1977	146	84
1978	108	127
1980	312	210
1981	78	195
	Post-decline	
1982	37	58
1983	17	27
1984	51	34
1985	29	40
1986	70	50
1987	72	71
1988	43	58
1989	76	60
1990	81	79
1991	171	126
1992	26	98
1993	400	213
1994*	**19**	**210**
1995*	**255**	**137**
1996*	**28**	**146**
1997*	**62**	**44****

*** - Criteria updated to 1997**
**** - Two-Year Running Average below 84 criteria**

Diversion Effects on Delta Smelt: Existing Conditions WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	-14
Entrainment (export)	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
CCF predation	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
Handling	0	0	0	0	0	0	-1	-2	-1	-1	0	0	
Hydrodynamics	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	0	0	0	
Qwest	0	0	0	0	0	0	0	0	0	0	0	0	
Old River @Bacon Island	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	-1	-1	-1	-1	-1	-1	0	0	0	0	-6
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	0	0	0	0	0	0	0	-1	-2	-2	-2	0	-7
Total	0	0	-7	-7	-7	-7	-11	-16	-12	-13	-9	-1	-48

Diversion Effects on Delta Smelt: Existing Conditions DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	-18
Entrainment (export)	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
CCF predation	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Handling	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Hydrodynamics	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	-18
Cross -Delta Flow	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Qwest	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Old River @Bacon Island	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Sac River @ Rio Vista	0	0	0	0	0	0	-1	-2	-2	-2	-1	0	
SJ River @ Antioch	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Predation	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-2	0	-14
Food supply	0	-1	-1	-1	-2	-3	-3	-3	-3	-3	-2	-1	-23
Shallow/ nearshore habitat	0	0	-1	-1	-1	-1	-1	-1	0	0	0	0	-6
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	-1	-1	-1	-4
Agricultural diversions	0	0	0	0	0	0	-2	-2	-3	-3	-2	0	-12
Total	-1	-2	-12	-12	-12	-22	-26	-38	-38	-38	-26	-2	-95

Diversion Effects on Delta Smelt: No Action Conditions WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-2	-2	-2	-3	-2	-3	-2	0	-18
Entrainment (export)	0	0	-1	-1	-2	-1	-2	-3	-2	-2	-1	0	
CCF predation	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
Handling	0	0	0	0	-1	-1	-1	-2	-1	-2	-1	0	
Hydrodynamics	0	0	-1	-1	-2	-2	-1	-2	-2	-2	-2	0	-15
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	0	0	0	
Qwest	0	0	0	-1	-1	-1	0	0	0	-1	-1	0	
Old River @Bacon Island	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	-1	-1	-1	-1	-1	-1	0	0	0	0	-6
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	0	0	0	0	0	0	0	-1	-2	-2	-2	0	-7
Total	0	0	-7	-8	-12	-11	-11	-17	-13	-17	-13	-1	-58

Diversion Effects on Delta Smelt: No Action Conditions DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-2	-2	-2	-3	-2	-3	-3	-3	-2	0	-22
Entrainment (export)	0	0	-2	-2	-2	-2	-2	-3	-3	-3	-2	0	
CCF predation	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Handling	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Hydrodynamics	0	0	-2	-2	-2	-3	-2	-3	-3	-3	-2	0	-22
Cross -Delta Flow	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Qwest	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Old River @Bacon Island	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Sac River @ Rio Vista	0	0	0	0	0	0	-1	-2	-2	-2	-1	0	
SJ River @ Antioch	0	0	-2	-2	-1	-1	-1	-2	-2	-2	-1	0	
Predation	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-2	0	-14
Food supply	0	-1	-2	-2	-2	-3	-3	-3	-3	-3	-2	-1	-25
Shallow/ nearshore habitat	0	0	-1	-1	-1	-1	-1	-1	0	0	0	0	-6
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	-1	-1	-1	-4
Agricultural diversions	0	0	0	0	0	0	-2	-2	-3	-3	-2	0	-12
Total	-1	-2	-17	-17	-15	-23	-25	-37	-37	-37	-25	-2	-105

Diversion Effects on Delta Smelt: Common Programs WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	-14
Entrainment (export)	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
CCF predation	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
Handling	0	0	0	0	0	0	-1	-2	-1	-1	0	0	
Hydrodynamics	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	0	0	0	
Qwest	0	0	0	0	0	0	0	0	0	0	0	0	
Old River @Bacon Island	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	0	0	1	1	1	1	1	0	0	0	5
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	2	2	-4	-4	-3	-2	-8	-9	-6	-8	-4	1	1

Diversion Effects on Delta Smelt: Common Programs DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	-18
Entrainment (export)	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
CCF predation	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Handling	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Hydrodynamics	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	-18
Cross -Delta Flow	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Qwest	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Old River @Bacon Island	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Sac River @ Rio Vista	0	0	0	0	0	0	-1	-2	-2	-2	-1	0	
SJ River @ Antioch	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Predation	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-2	0	-14
Food supply	1	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	-6
Shallow/ nearshore habitat	0	0	0	0	1	1	1	1	0	0	0	0	4
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	-1	-1	-1	-4
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	1	0	-9	-9	-8	-17	-19	-30	-31	-31	-21	0	-40

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Diversion Effects on Delta Smelt: Alternative 1 WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-2	-2	-2	-3	-2	-3	-2	0	-18
Entrainment (export)	0	0	-1	-1	-2	-1	-2	-3	-2	-2	-1	0	
CCF predation	0	0	-1	-1	-1	-1	-2	-3	-2	-2	-1	0	
Handling	0	0	0	0	-1	-1	-1	-2	-1	-2	-1	0	
Hydrodynamics	0	0	-1	-1	-2	-2	-1	-2	-2	-2	-2	0	-15
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	0	0	0	
Qwest	0	0	0	-1	-1	-1	0	0	0	-1	-1	0	
Old River @Bacon Island	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	0	0	1	1	1	1	1	0	0	0	5
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	2	2	-4	-5	-8	-6	-6	-10	-7	-12	-8	1	-9

Diversion Effects on Delta Smelt: Alternative 1 DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-2	-2	-2	-3	-2	-3	-3	-3	-2	0	-22
Entrainment (export)	0	0	-2	-2	-2	-2	-2	-3	-3	-3	-2	0	
CCF predation	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Handling	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Hydrodynamics	0	0	-2	-2	-2	-3	-2	-3	-3	-3	-2	0	-22
Cross -Delta Flow	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Qwest	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Old River @Bacon Island	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Sac River @ Rio Vista	0	0	0	0	0	0	-1	-2	-2	-2	-1	0	
SJ River @ Antioch	0	0	-2	-2	-1	-1	-1	-2	-2	-2	-1	0	
Predation	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-2	0	-14
Food supply	1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-8
Shallow/ nearshore habitat	0	0	0	0	1	1	1	1	0	0	0	0	4
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	-1	-1	-1	-4
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	1	0	-14	-14	-11	-18	-18	-29	-30	-30	-20	0	-50

Diversion Effects on Delta Smelt: Alternative 2 WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-2	-2	-2	-2	-2	-3	-2	-3	-2	0	-20
Entrainment (export)	0	0	-1	-1	-1	-1	-2	-3	-2	-1	-1	0	
CCF predation	0	0	-1	-1	-2	-2	-2	-3	-2	-2	-1	0	
Handling	0	0	0	0	-1	-1	-1	-2	-2	-1	0	0	
Hydrodynamics	0	0	-2	-2	-2	-2	-2	-3	-2	-3	-2	0	-20
Cross -Delta Flow	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	
Qwest	0	0	0	0	0	0	0	0	0	0	0	0	
Old River @Bacon Island	0	0	-1	-2	-2	-2	-2	-2	-1	-1	-1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	0	0	0	0	0	0	0	0	0	0	0
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	2	2	-8	-9	-11	-10	-11	-15	-11	-12	-8	1	-21

Diversion Effects on Delta Smelt: Alternative 2 DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-3	-3	-3	-3	-3	-3	-3	-3	-2	0	-26
Entrainment (export)	0	0	-1	-1	-1	-1	-2	-3	-3	-3	-2	0	
CCF predation	0	0	-1	-1	-2	-2	-2	-3	-3	-3	-2	0	
Handling	0	0	-1	-1	-1	-2	-2	-3	-3	-3	-2	0	
Hydrodynamics	0	0	-3	-3	-3	-3	-3	-3	-3	-3	-2	0	-26
Cross -Delta Flow	0	0	-2	-2	-2	-2	-2	-3	-3	-3	-2	0	
Qwest	0	0	0	0	0	0	0	0	-1	-1	-1	0	
Old River @Bacon Island	0	0	-1	-2	-2	-2	-2	-3	-3	-3	-2	0	
Sac River @ Rio Vista	0	0	-2	-2	-2	-2	-1	-1	-2	-2	-1	0	
SJ River @ Antioch	0	0	0	0	0	0	0	0	0	0	0	0	
Predation	0	0	-1	-1	-1	-2	-2	-2	-2	-2	-2	0	-15
Food supply	1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-8
Shallow/ nearshore habitat	0	0	0	0	-1	-1	-1	-1	0	0	0	0	-4
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	-1	-1	-1	-4
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	1	0	-15	-16	-17	-19	-19	-25	-26	-26	-18	0	-67

Diversion Effects on Delta Smelt: Alternative 3 WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	1	1	1	1	2	2	1	1	1	0	11
Entrainment (export)	0	0	1	1	1	1	2	2	1	1	1	0	
CCF predation	0	0	1	1	1	1	2	2	1	1	1	0	
Handling	0	0	0	0	0	0	-1	-2	-1	-1	0	0	
Hydrodynamics	0	0	1	2	2	2	2	2	1	1	1	0	14
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	0	0	0	
Qwest	0	0	0	0	0	0	0	0	0	0	0	0	
Old River @Bacon Island	0	0	1	1	1	1	1	1	1	1	1	0	
Sac River @ Rio Vista	0	0	0	0	0	0	0	0	0	0	0	0	
SJ River @ Antioch	0	0	1	1	1	1	1	1	1	1	1	0	
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	2	1	1	0	14
Salinity/X2	0	0	0	0	0	0	0	0	0	-1	-1	-1	-3
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	2	2	9	10	11	12	14	14	10	8	9	1	67

Diversion Effects on Delta Smelt: Alternative 3 DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	1	1	2	2	2	3	2	2	1	1	17
Entrainment (export)	0	0	1	1	2	2	2	3	2	2	1	1	
CCF predation	0	0	1	1	2	2	2	3	2	2	1	1	
Handling	0	0	0	0	0	-1	-1	-2	-2	-2	-1	0	
Hydrodynamics	0	0	0	0	1	1	1	1	1	1	1	0	7
Cross -Delta Flow	0	0	0	0	0	0	0	0	0	1	1	0	
Qwest	0	0	0	0	0	0	0	0	0	0	0	0	
Old River @Bacon Island	0	0	0	0	1	1	1	1	1	0	0	0	
Sac River @ Rio Vista	0	0	-1	-1	-1	-1	-1	0	-1	0	0	0	
SJ River @ Antioch	0	0	1	1	1	1	1	1	1	1	1	0	
Predation	0	0	0	0	0	1	1	1	1	1	0	0	5
Food supply	1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-8
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	1	1	1	0	13
Salinity/X2	-1	-1	0	0	1	1	1	-1	-1	0	0	-1	-2
Agricultural diversions	1	1	1	1	1	1	1	2	2	2	2	1	16
Total	1	0	4	4	11	11	11	13	8	10	7	3	48

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Net Effects Matrices with Common Programs Included

Net Effects Matrices with Common Programs Included
No Action Conditions - Existing

WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	0	0	-1	-1	0	0	0	-1	-1	0	-4
Hydrodynamics	0	0	0	0	-1	-1	0	-1	-1	-1	-1	0	-6
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	0	0	0	0	0	0	0	0	0	0	0
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	-2	-2	0	-1	-1	-2	-2	0	-10

Net Effects Matrices with Common Programs Included
No Action Conditions - Existing

DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Hydrodynamics	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	0	0	-1	-1	0	0	0	0	0	0	0	0	-2
Shallow/ nearshore habitat	0	0	0	0	0	0	0	0	0	0	0	0	0
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	-3	-3	-2	-2	0	0	0	0	0	0	-10

Net Effects Matrices with Common Programs Included
Common Programs - Existing

WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrodynamics	0	0	0	0	0	0	0	0	0	0	0	0	0
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	1	0	0	0	11
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	1	3	4	4	4	1	23
Total	2	2	3	3	4	5	5	7	6	5	5	2	49

Net Effects Matrices with Common Programs Included
Common Programs - Existing

DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrodynamics	0	0	0	0	0	0	0	0	0	0	0	0	0
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	1	1	1	2	2	2	2	2	1	1	17
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	0	0	0	0	10
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	3	4	5	5	4	1	28
Total	2	2	3	3	4	5	7	8	7	7	5	2	55

Net Effects Matrices with Common Programs Included
Alternative 1 - Existing WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	0	0	-1	-1	0	0	0	-1	-1	0	-4
Hydrodynamics	0	0	0	0	-1	-1	0	-1	-1	-1	-1	0	-6
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	1	0	0	0	11
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	1	3	4	4	4	1	23
Total	2	2	3	3	2	3	5	6	5	3	3	2	39

Net Effects Matrices with Common Programs Included
Alternative 1 - Existing DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Hydrodynamics	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	0	0	1	2	2	2	2	2	1	1	15
Shallow/ nearshore habitat	0	0	1	1	2	2	2	2	0	0	0	0	10
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	3	4	5	5	4	1	28
Total	2	2	0	0	2	3	7	8	7	7	5	2	45

Net Effects Matrices with Common Programs Included
Alternative 2 - Existing WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	0	0	0	-1	-1	0	-6
Hydrodynamics	0	0	-1	-1	-1	-1	-1	-2	-1	-2	-1	0	-11
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	1	1	1	1	1	1	0	0	0	0	6
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	1	3	4	4	4	1	23
Total	2	2	1	1	1	2	3	4	4	2	3	2	27

Net Effects Matrices with Common Programs Included
Alternative 2 - Existing DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-2	-2	-2	-1	-1	0	0	0	0	0	-8
Hydrodynamics	0	0	-2	-2	-2	-1	-1	0	0	0	0	0	-8
Predation	0	0	0	0	0	-1	0	0	0	0	0	0	-1
Food supply	1	1	0	0	1	2	2	2	2	2	1	1	15
Shallow/ nearshore habitat	0	0	1	1	0	0	0	0	0	0	0	0	2
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	3	4	5	5	4	1	28
Total	2	2	-2	-2	-2	0	3	6	7	7	5	2	28

Net Effects Matrices with Common Programs Included
Alternative 3 - Existing WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	2	2	2	2	4	5	3	3	2	0	25
Hydrodynamics	0	0	2	3	3	3	3	3	2	2	2	0	23
Predation	0	0	1	1	1	1	1	1	1	1	1	0	9
Food supply	1	1	1	1	1	2	2	2	1	1	1	1	15
Shallow/ nearshore habitat	0	0	2	2	3	3	3	3	2	1	1	0	20
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	1	1	1	1	1	1	1	3	4	4	4	1	23
Total	2	2	9	10	11	12	14	17	13	12	11	2	115

Net Effects Matrices with Common Programs Included
Alternative 3 - Existing DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	
Entrainment	0	0	2	2	3	4	4	6	5	5	3	1	35
Hydrodynamics	0	0	1	1	2	3	3	4	4	4	3	0	25
Predation	0	0	1	1	1	2	3	3	3	3	2	0	19
Food supply	1	1	0	0	1	2	2	2	2	2	1	1	15
Shallow/ nearshore habitat	0	0	2	2	3	3	3	3	1	1	1	0	19
Salinity/X2	0	0	0	0	0	0	0	0	0	1	1	0	2
Agricultural diversions	1	1	1	1	1	1	3	4	5	5	4	1	28
Total	2	2	7	7	11	15	18	22	20	21	15	3	143

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Alternative Matrices WITHOUT Common Programs
Alternative 1 - Common Programs — WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	0	0	-1	-1	0	0	0	-1	-1	0	-4
Hydrodynamics	0	0	0	0	-1	-1	0	-1	-1	-1	-1	0	-6
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	0	0	0	0	0	0	0	0	0	0	0
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	-2	-2	0	-1	-1	-2	-2	0	-10

Alternative Matrices WITHOUT Common Programs
Alternative 1 - Common Programs — DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Hydrodynamics	0	0	-1	-1	-1	-1	0	0	0	0	0	0	-4
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	0	0	-1	-1	0	0	0	0	0	0	0	0	-2
Shallow/ nearshore habitat	0	0	0	0	0	0	0	0	0	0	0	0	0
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	-3	-3	-2	-2	0	0	0	0	0	0	-10

Alternative Matrices WITHOUT Common Programs
Alternative 2 - Common Programs — WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-1	-1	-1	-1	0	0	0	-1	-1	0	-6
Hydrodynamics	0	0	-1	-1	-1	-1	-1	-2	-1	-2	-1	0	-11
Predation	0	0	0	0	0	0	0	0	0	0	0	0	0
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	0	0	-1	-1	-1	-1	-1	0	0	0	-5
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	-2	-2	-3	-3	-2	-3	-2	-3	-2	0	-22

Alternative Matrices WITHOUT Common Programs
Alternative 2 - Common Programs — DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	-2	-2	-2	-1	-1	0	0	0	0	0	-8
Hydrodynamics	0	0	-2	-2	-2	-1	-1	0	0	0	0	0	-8
Predation	0	0	0	0	0	-1	0	0	0	0	0	0	-1
Food supply	0	0	-1	-1	0	0	0	0	0	0	0	0	-2
Shallow/ nearshore habitat	0	0	0	0	-2	-2	-2	-2	0	0	0	0	-8
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	-5	-5	-6	-5	-4	-2	0	0	0	0	-27

Alternative Matrices WITHOUT Common Programs
Alternative 3 - Common Programs — WET YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	2	2	2	2	4	5	3	3	2	0	25
Hydrodynamics	0	0	2	3	3	3	3	3	2	2	2	0	23
Predation	0	0	1	1	1	1	1	1	1	1	1	0	9
Food supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow/ nearshore habitat	0	0	1	1	1	1	1	1	1	1	1	0	9
Salinity/X2	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	6	7	7	7	9	10	7	7	6	0	66

Alternative Matrices WITHOUT Common Programs
Alternative 3 - Common Programs — DRY YEARS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
Entrainment	0	0	2	2	3	4	4	6	5	5	3	1	35
Hydrodynamics	0	0	1	1	2	3	3	4	4	4	3	0	25
Predation	0	0	1	1	1	2	3	3	3	3	2	0	19
Food supply	0	0	-1	-1	0	0	0	0	0	0	0	0	-2
Shallow/ nearshore habitat	0	0	1	1	1	1	1	1	1	1	1	0	9
Salinity/X2	0	0	0	0	0	0	0	0	0	1	1	0	2
Agricultural diversions	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	4	4	7	10	11	14	13	14	10	1	88

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